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ABSTRACTS.

The Relation between Ice-Lobes South from the Wisconsin Driftless Area.

By FRANK LEVERETT, Denmark, Iowa.

Instead of a coalescence of ice-lobes from the east and west sides of the driftless area in the drift-covered district to the south there was an invasion and withdrawal of one lobe (the western) before the other reached its culmination. The eastern lobe encroached upon territory previously glaciated by the western, depositing a distinct sheet of drift and forming at its western limits a well-defined morainic ridge. There appears to have been a period of considerable length between the withdrawal of the western lobe and the culmination of the eastern.

Subsequently, however, there was a readvance of the lobe on the west into northeastern Iowa, and this readvance appears to have been contemporaneous with the nearly complete occupancy of northwestern Illinois by the eastern ice-lobe. It seems not improbable that the ice-lobes were then, for a brief period, coalesced for a short distance about the south border of the driftless area. Evidence of complete coalescence, however, is not decisive so far as yet discovered.

These developments serve to throw light upon the cause for the scarcity of lacustrine deposits in the driftless area. They show that there was at most but a brief period in which the southward drainage of the driftless area was completely obstructed by the ice-sheet.

The Production of Coal in 1894. By EDWARD W. PARKER. *Extract from the 16th Annual Report of the U. S. Geological Survey, Part IV., Mineral Resources of the United States.*

This report, consisting of 224 pages, constitutes the first chapter of Part IV. of the 16th annual report of the Director, the well-known volume of "Mineral Resources" having, by a recent act of Congress, been made a part of the Directors' report. This chapter, with four others, has been published and given to the public in advance of the complete volume. As indicated by the title, the chapter is principally a statistical compilation, giving in great detail the record of coal production

in 1894, with a résumé of the industry in previous years. The tables show the production by fields, such as the Appalachian, the Central, the Western, etc.; by states and by counties in the states. They also show the value of the output, and the number of men employed, and the amount of time taken to win it. The result of the prolonged strike in the bituminous regions is shown in a reduced production in 1894 as compared with 1893 of more than eleven and a half million tons. The loss in labor to the miners and other employés who were thrown out of employment by the strike is shown to have been the equivalent of 5,167,357 men for one day, or of 17,224 men for one year of 300 working days.

The effects of the business depression and general low value for commodities is illustrated in the coal mining industry by a decrease in the value of the product in 1894 of over \$22,000,000, more than ten per cent. less than that of 1893, while the amount of the product was only 6 per cent. less than the preceding year.

An interesting feature of Mr. Parker's report is a series of contributions from secretaries of boards of trade, etc., in the larger cities, which furnishes useful information regarding the coal trade of those cities, and the effects of the strike and other influences upon the movement of coal from the producing to the consuming centers.

Merocrinus Salopia, n. sp., and another Crinoid, from the Middle Ordovician of West Shropshire. By F. A. BATHER. *Geol. Mag.*, n. s., Vol. III, pp. 71-75, February 1896.

Merocrinus is a genus of dicyclic inadunate crinoids, hitherto recorded only from the Utica shale of Ohio (Ulrich) and the Trenton limestone of New York (Walcott). The discovery of a species in the Middleton group, Meadow Town series of Mincop in Shropshire, England, is therefore of interest to American geologists. It is thus diagnosed: "Radials and Basals, as high as wide. Arms slender, bifurcating at intervals of eight or more ossicles. Brachials wider, or with a slight cornice at their distal margin." The other crinoid described and figured presents peculiar features, especially in the arms, but is too imperfect to be referred to any known genus.

U. S. Geologic Atlas., Folio 10, Harper's Ferry, Virginia; Maryland; West Virginia, 1894.

This folio consists of four pages of descriptive text, signed by

Arthur Keith, geologist; one page of columnar section, a topographic map (scale 1:125000), a sheet showing the areal geology of the district; another showing the economic geology, and a third exhibiting structure sections.

The folio describes that portion of the Appalachian province which is situated between parallels 39° and $39^{\circ} 30'$ and meridians $77^{\circ} 30'$ and 78° . The tract contains about 950 square miles, and falls within Washington and Frederick counties, Maryland; Loudoun and Fauquier counties, Virginia; and Jefferson county, West Virginia.

The folio begins with a general description of the province, which shows the relation of the Harper's Ferry tract to the whole. The local features of the drainage by the Potomac and Shenandoah Rivers and their tributaries (Goose, Antietam, and Catoctin Creeks) are treated. The various forms of the surface are pointed out, such as Shenandoah Valley, Blue Ridge, and Catoctin Mountain, and their relations to the underlying rocks are made clear.

Under the heading Stratigraphy the geologic history of the Appalachian province is presented in outline, and the local rock groups are fully described in regard to composition, thickness, location, varieties, and mode of deposition.

The formations range in age from Algonkian to Cretaceous, the greater portion being Algonkian, Cambrian and Silurian. The Silurian rocks appear in Shenandoah Valley, the Cambrian in Catoctin Mountain and Blue Ridge, the Algonkian between these ridges, and the Juratrias east of Catoctin. The Algonkian rocks are chiefly granite and epidotic schist; the Cambrian rocks, sandstones and shales, passing up into limestones; the Silurian rocks, limestones and shales; and the Juratrias rocks, red sandstone and shale and limestone conglomerate. The details of the strata are shown in the columnar section. The manner in which each kind of rock decays is discussed, and how the residual soils and forms of surface depend on the nature of the underlying rock.

In the discussion of Structure, after a general statement of the broader structural features of the province, three methods are shown in which the rocks have been deformed. Of these the extreme Appalachian folding is the chief; next is that developed in the Juratrias rocks; and least in importance are the broad vertical uplifts. Three degrees of extreme deformation appear in the Palæozoic rocks—folding, faulting, and metamorphism—each being best developed in a certain kind

of strata. Between Blue Ridge and Catoclin Mountain the Algonkian or oldest rocks appear on a great anticlinal uplift, with Cambrian rocks on either side. Faults appear chiefly on the west side of this uplift, and metamorphism increases toward its side. In Shenandoah Valley the rocks are folded to an extreme degree, and the strata are frequently horizontal or overturned. The Juratrias rocks always dip toward the west, and are probably repeated by faults different in nature from the Appalachian faults. In the sheet of sections the details of the folds and faults appear.

Economic products of this region comprise copper and iron ore; ornamental stones, such as marble, limestone conglomerate, and amygdaloid; building stones, such as sandstone, limestone, and slate; and other materials like lime, cement, brick-clay, and road materials. The localities of each of these materials are noted and quarries located on the economic sheet, and the character and availability of the deposits are discussed.

Geologic Atlas of the United States. Folio 2, Ringgold, Georgia, Tennessee, 1894.

This folio consists of three pages of text, signed by C. Willard Hayes, geologist; a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, one of structure sections, and one giving columnar sections.

Geography.—The district of country covered by this folio lies mainly in Georgia, a narrow strip about a mile in width along its northern border extending into Tennessee. It embraces portions of Dade, Catoosa, Walker, Whitfield, Chattooga, Floyd, and Gordon counties in Georgia, and of Madison, Hamilton, and James counties in Tennessee. The region forms a part of the great Appalachian Valley. Its surface is marked by three distinct types of topography viz.: plateaus, formed by hard rocks whose beds are nearly horizontal; sharp ridges, formed by hard rocks whose beds are steeply inclined; and level or undulating valleys, formed on soft or easily eroded rocks. The plateaus are confined to the western third of the district, and include portions of Lookout and Sand mountains. Their surface is generally level or rolling, with a slight inclination from the edges toward the center, giving the plateaus the form of a shallow trough. They are bounded by steep escarpments rising from 1000 to 1200 feet above the surrounding valleys. The sharp ridges are confined to

the eastern third of the district, while a broad undulating valley occupies its central portion. The latter is drained in part northward by tributaries of the Tennessee and in part southward by streams flowing directly to the Gulf. The divide separating the two drainage systems is broad and low, and there is evidence that the Tennessee River formerly flowed southward across the divide.

Geology—The rocks appearing at the surface within the Ringgold district are entirely of sedimentary origin, and include representatives of all the Palæozoic groups. The oldest rocks exposed are shales, sandstones, and thin-bedded limestones of Lower and Middle Cambrian age. These are called the Apison shale, Rome sandstone, and Conasauga shale. Above these formations is a great thickness of siliceous magnesium limestone, the Knox dolomite, the lower portion probably being Cambrian and the upper portion Silurian. The remaining Silurian formations are the Chickamauga limestone and the Rockwood sandstone. The Devonian is either wholly wanting or is represented by a single thin bed of carbonaceous shale, not over 35 feet in thickness. Above the Chattanooga black shale are the Fort Payne chert, Floyd shale, and Bangor limestone forming the Lower Carboniferous, and the Lookout and Walden sandstones forming the Coal Measures. Most of the formations thicken eastward, and at the same time the proportion of calcareous matter decreases, showing that the land from which the materials composing the rocks were derived lay to the east.

The region has been subjected to compression in a northwest-southeast direction, and the originally horizontal strata would have been thrown into a series of long, narrow folds whose axes extend at right angles to the direction of the compression, or northeast and southwest. The effects of compression were greatest in the eastern portion of the district, where the strata are now all steeply inclined and the basal beds form sharp ridges, while in the western portion considerable areas of strata remain nearly horizontal and form plateaus. Where the folding was greatest there was also much fracturing of the rocks, and the strata on the eastern side of a fracture are in many places thrust upward and across the broken edges of the corresponding strata on the west. Most of the ridges in the district have thrust faults of this character along their eastern basis.

Mineral Resources.—These consist of coal, iron ore, mineral paint, manganese ore, limestone, building stone, and brick and tile clay. The productive coal-bearing formations, the Lookout and Walden

sandstones, occupy the upper portions of Pigeon, Lookout and Sand mountains, having an area in this district of 116 square miles. The Lookout generally contains one, and in some places two or three, workable coal seams, but they are variable in position, extent, and thickness. The Walden sandstone forms a considerable area on Lookout Mountain, and contains at least one valuable seam of coal, which is extensively worked at the Durham mines. Two varieties of iron ore are found in workable quantities. The first is the red fossil or "Clinton" ore, which occurs as a regularly stratified bed in the Rockwood formation, and is worked at various places along the base of Lookout Mountain. The second variety is limonite, which occurs as a pocket deposit at the base of several of the ridges along the eastern border of the district. Associated with the latter, particularly along the faults, are deposits of manganese, generally as nodules scattered through the surface soil.

Geologic Atlas of the United States. Folio 4, Kingston, Tennessee, 1894.

This folio consists of three and one-half pages of text, signed by C. Willard Hayes, geologist; a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, one of structure sections, and one giving columnar sections.

Geography.—The map is bounded by the parallels $35^{\circ} 30'$ and 36° , and the meridians $84^{\circ} 30'$ and 85° . The district represented lies wholly within the state of Tennessee, and includes portions of Cumberland, Morgan, Roane, Rhea, Loudon, Meigs, and McMinn counties. Its area is approximately 1000 square miles, and it forms a part of the Appalachian province, being about equally divided between the valley and plateau divisions of the province. The northwestern half of the district is a portion of the Cumberland Plateau. The surface of this half, except in the Crab Orchard Mountains, is comparatively level and has an altitude of between 1800 and 1900 feet. Its streams flow in shallow channels until near the edge of the plateau, when they plunge into rocky gorges which form deep notches in the escarpment. The Crab Orchard Mountains are formed by the uneroded portions of an anticline, the hard bed rising in the form of a low arch. Toward the southwest the hard beds were lifted higher, and have been removed, exposing the easily erodible limestone beneath, and in this the Sequatchie Valley has been excavated. The southeastern half of the district

lies within the great Appalachian Valley, here occupied by the Tennessee River, which flows at an altitude of about 700 feet, and above which rounded hills and ridge rise from 300 to 500 feet higher. The valley ridges have a uniform northeast-southwest trend, parallel with the Cumberland escarpment, their location depending on outcrop of narrow belts of hard rocks.

Geology.—West of the Cumberland escarpment the geologic structure is very simple. The strata remain nearly horizontal, as they were originally deposited, except in the Crab Orchard Mountains, where they bend upward, forming a low arch. East of the escarpment the strata have suffered intense compression, which has forced them into a great number of narrow folds whose axes extend northeast and southwest. The strata dip more steeply on one side of the arch than on the other; and as a further effect of compression, the beds on the steeper (generally the northwestern) side have been fractured and the rocks on one side thrust upward across the broken edges of those on the other. In this manner the folds first formed have in most cases been obliterated, and there remain narrow strips of strata separated by faults, and all dipping to the southeast.

The rocks appearing at the surface are entirely sedimentary—limestones, shales, sandstones, and conglomerates—and include representatives of all the Palæozoic groups. The Cambrian formations consist of the Apison shale, Rome sandstone, and Conasauga shale, a series which is calcareous at top and bottom and siliceous in the middle. The Conasauga passes upward through blue shaly limestone into the Knox dolomite, a formation about 4000 feet in thickness, composed of siliceous or cherty magnesian limestone. Probably the lower portion is of Cambrian age, while the upper is undoubtedly Silurian. Above the dolomite is the Chickamauga limestone, whose upper portion toward the eastern side of the district changes from blue flaggy limestone to calcareous shale, and is called the Athens shale. The next formation is the Rockwood, which also changes toward the east from calcareous shale to hard, brown sandstone. These changes in the character of the rocks indicate that, while they were forming, the land from which their materials were derived lay to the southeast. The Devonian is represented in this region by a single stratum of carbonaceous shale, the Chattanooga black shale, which rests, probably with a slight unconformity, on the Rockwood. Above the Chattanooga are the Fort Payne chert and Bangor limestone of the lower

Carboniferous, and the Lookout and Walden sandstones of the Coal Measures.

Mineral resources.—These consist of coal, iron ore, limestone, building stone, and clay. The coal-bearing formations, the Walden and Lookout, form the surface of the greater part of the district northwest of the Cumberland escarpment, making a probably productive area of 370 square miles. The Lookout always contains one and sometimes as many as four beds, all of which are locally though not generally workable. The upper bed, immediately below the conglomerate, is the most constant. The greater part of the workable coal is contained in the Walden, the lower bed probably corresponding to the Sewanee seam farther west. This occurs in a belt six or eight miles in width along the eastern edge of the plateau. The only iron ore sufficiently abundant to be commercially important is the red fossil ore, which occurs as a regularly stratified bed in the Rockwood formation. The numerous folds east of the escarpment bring the Rockwood to the surface in long, narrow bands, along which the ore has been worked at many points. It varies in thickness from three to seven feet, and although at some places it passes into a sandy shale, it is generally a high grade ore.

Geologic Atlas of the United States. Folio 6, Chattanooga, Tennessee, 1894.

This folio consists of three pages of text, signed by C. Willard Hayes, geologist; a topographical sheet (scale 1 : 125,000), a sheet of areal geology, one of economic geology, one of structure sections, and one giving columnar sections.

Geography.—The map is bounded by the parallels 35° and 35° 30' and the meridians 85° and 85° 30'. The district is wholly within the State of Tennessee, embracing portions of Bledsoe, Rhea, Sequatchie, Marion, Hamilton, and James counties. It lies partly in the great Appalachian Valley and partly in the plateau division of the Appalachian province. Its surface is marked by two distinct types of topography, the plateau and the valley. The former prevails in the western half of the district, which is occupied by portions of the Cumberland Plateau and Walden Ridge, the two plateaus being separated by Sequatchie Valley. The Cumberland Plateau has an altitude of about 2100 feet, with a level or rolling surface. Walden Ridge has an altitude of 2200 feet along its western edge, and slopes gradually eastward down to 1700 feet. Both plateaus are bounded by abrupt escarpments

from 900 to 1400 feet in height, the upper portions being generally formed by a series of cliffs. The two plateaus are separated by Sequatchie Valley, which is about four miles in width. Its western side, the escarpment of Cumberland Plateau, is notched by numerous deep, rocky gorges, cut backward into the plateau by streams flowing from its surface; while the eastern side, the Walden escarpment, forms an unbroken wall. The eastern half of the district is occupied by the Tennessee Valley, the river itself having an altitude of between 600 and 700 feet, while rounded hills and irregular ridges rise several hundred feet higher. Leaving the broad valley, which continues southward into Alabama, the Tennessee River turns abruptly westward at Chattanooga and enters a narrow gorge through Walden Ridge. This part of its channel is very young in comparison with the valley toward the north, and there is evidence that the river has occupied its present course but a short time, having formerly flowed southward directly to the gulf.

Geology.—The rocks appearing at the surface within the limits of the map are entirely of sedimentary origin, and include representatives of all the Palæozoic groups. The Cambrian formations include the Apison shale, Rome sandstone, and Conasauga shale, a series which is calcareous at top and bottom and siliceous in the middle. The Conasauga passes upward through the blue limestone into the Knox dolomite—a great thickness of siliceous magnesium limestone, the lower portion of which is probably Cambrian. Above the dolomite are Chicamauga limestone and Rockwood shale, the latter becoming brown sandstone in White Ash Mountain. The whole of the deposition which took place in this region during the Devonian is apparently represented by a stratum of shale from ten to twenty-five feet in thickness—the Chattanooga black shale, which probably rests unconformably upon the Rockwood. Above the Chattanooga are the Fort Payne chert and Bangor limestone, forming the lower Carboniferous, and the Lookout and Walden sandstones, forming the Coal Measures. Nearly all the formations exhibit an increase in thickness and in proportion of sand and mud toward the east, showing that the land from which their materials were derived lay to the east and southeast.

The geologic structure is simple in the region occupied by the plateaus, and complicated in the valleys. In the Cumberland Plateau the strata are almost perfectly horizontal, while in Walden Ridge they have a slight dip from the edges toward the center. Sequatchie Valley

is located upon the westernmost of the sharp anticlines which characterize the central division of the Appalachian province. In the eastern part of the district the strata have suffered compression, which has forced the originally horizontal strata into a series of long, narrow folds whose axes extend in a northeast-southwest direction. In addition to the folding, and as a further effect of the compression which produced it, the strata have been fractured along many lines parallel with the folds, and the rocks upon one side—generally the eastern—have been thrust upward and across the broken edges of those on the other side. A fault of this character passes along the western side of the Sequatchie Valley, and several formations which would normally occur there are entirely concealed.

Mineral resources.—These consist of coal, iron ore, limestone, building stone, and brick and tile clay. The productive coal-bearing formations, the Lookout and Walden sandstones, occupy the surface of the plateaus. They have an area within the district of about 400 square miles, and contain from one to three beds of workable coal. The beds in the Lookout are generally variable in position, extent, and thickness; those in the Walden are constant over large areas, and are worked on a considerable scale at various points along the eastern side of Walden Ridge. About 200 square miles of area of these upper coals occur within the district, on the Cumberland Plateau and in the eastern half of Walden Ridge. The most important iron ore in the district is the red fossil or Clinton ore, which occurs as a regularly stratified bed in the Rockwood shale. The bed is from three to five feet thick in Sequatchie Valley, but considerably thinner in the vicinity of Chattanooga and eastward.

Geologic Atlas of the United States, Folio 8, Sewanee, Tennessee, 1894.

This folio consists of nearly four pages of text, signed by Charles Willard Hayes, geologist; a topographic sheet (scale 1:125,000), a sheet of areal geology, one of economic geology, one of structure sections, and one giving columnar sections.

Geography.—The map is bounded by the parallels 35° and $35^{\circ} 30'$ and the meridians $85^{\circ} 30'$ and 86° , and the territory it represents is wholly within Tennessee, embracing portions of Grundy, Sequatchie, Marion, Franklin, and Coffee counties. The district lies almost wholly within the western or plateau division of the Appalachian province. Crossing its southeastern corner is the Sequatchie Valley, located upon

the westernmost of the sharp folds which characterize the central or valley division of the province. The larger part of the district is occupied by the Cumberland Plateau, which has a gradual ascent toward the north, rising from an altitude of between 1700 and 1800 feet on the south to 1900 or 2000 feet on the north. The plateau is limited by a steep escarpment from 1100 to 1500 in height on the east and about 1000 feet in height on the west. Many streams have cut their channels backward into the plateau, forming deep, narrow caves, so that the escarpment forms an extremely irregular line. Small portions of Walden Ridge and Sand Mountain appear in the extreme southeastern corner of the district, these being plateaus similar to the Cumberland Plateau farther west. A small portion of the Sequatchie Valley occupies the southeastern part of the district, with an altitude of about 600 or 700 feet, while its northwestern portion is within the "highland rim" a broad terrace surrounding the lowlands of middle Tennessee and separating on the east from the Cumberland Plateau.

Geology.—The rocks appearing at the surface are of sedimentary origin, and include representatives of all the geologic periods from Silurian to Carboniferous. The Silurian formations, consisting of the Knox dolomite, Chickamauga limestone, and Rockwood shale, occur only, as narrow belts in the Sequatchie Valley. The same is true of the Devonian, which is represented by a single thin formation, the Chattanooga black shale. The Carboniferous formations occupy by far the larger part of the district, the Fort Payne chert and Bangor limestone forming the lower portions of the plateau escarpments and the highland rim, while the Lookout and Walden sandstones, belonging to the Coal Measures, form the summits of the plateaus.

The geologic structure of the region is in general extremely simple. The plateaus and the highland rim to the westward are underlain by nearly horizontal strata, while the Sequatchie Valley is upon a sharp, narrow fold, the beds dipping downward on either side beneath the adjoining plateaus. If the rocks which have been eroded from the top of this arch were restored, there would be a ridge several thousand feet in height in place of the present valley. In addition to the folding which the strata have suffered along this line, they have also been fractured, and the beds on the east have been thrust upward and across the edges of corresponding beds on the west of the fracture, so that along the western side of the valley the formations do not appear at the surface in their normal sequence.

Mineral resources.—These consist of coal, iron ore, limestone, building and road stone, and clays. The Coal Measures occupy an area within the district of about 500 square miles. Not all of this area, however, contains coal beds of workable thickness, while some portions contain two or three workable beds. The lower beds occurring in the Lookout sandstone, are variable in horizontal position, thickness, and extent, so that they cannot profitably be worked on a large scale; but they have been opened at many points, and supply an excellent fuel for local use. The Sewanee seam, which is found in the Walden sandstone, from 50 to 70 feet above its base, is the most important seam in the district. It has an average thickness of four to five feet over at least 80 square miles in the higher portions of the plateau, and is extensively mined for coking at Tracy and Whitwell. The iron ore of chief importance is the red fossil or "Clinton" ore, which occurs as a regularly stratified bed in the Rockwood shale. At Inman, in the Sequatchie Valley, it attains a thickness of 5.5 feet and is extensively mined.